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Review

# Sustainable intensification: A UK perspective

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ABSTRACT

Sustainable intensification (SI) is a term that has increasingly been used to describe the agricultural production systems that will be needed to feed a growing global population whilst ensuring adequate ecosystem service provision. However, key definitions of SI support quite different approaches; a report published by the Royal Society (Baulcombe et al., 2009) favours the land sparing model whilst a Foresight report (2011) favours land sharing. SI will require pragmatic and innovative policies, including further revision of the Environmental Stewardship Scheme and the development of landscape-scale governance within an over-arching strategic approach to planning. However, its innovation is its focus on unlocking the social at the expense of the private value of land (at those locations where non-market ecosystem services have a higher value than marketable agricultural products). Though scientific advances may help raise production efficiency through a better understanding of the trade-offs between agricultural production and ecosystem service provision, issues related to who controls the use of land will be the most difficult to resolve, which suggests a role for Boundary Organisational Theory (BOT) because of the insights this theory lends to negotiating complex problems. Within BOT terminology SI can be considered a "boundary object" about which stakeholders are able to negotiate site-specific issues to incrementally arrive at solutions which draw on the full range of land sharing and land sparing options and so avoid prescriptive approaches and technologies.



## Introduction

The term sustainable intensification (SI) was initially used in the mid 1990s in the context of developing food production in Africa (Pretty, 1997; Garnett and Godfray, 2012). For example, "Strategic Objective A" of FAO Strategic Framework (2009–2025) is titled "The SI of crop production" (FAO, 2010b: p1 and p7; FAO, 2011). In the UK context the phrase perhaps first came to prominence in a report published by the Royal Society (Baulcombe et al., 2009). The notion of SI was taken up by the Foresight Programme. Created in 1994 to help the UK government think systematically about the future, it listed as one of "twelve key priorities for action for policy makers" in its "Global Food and Farming Future" study the need to "Promote sustainable intensification" (Foresight, 2011 Box 8.1, p. 34).

The notion of SI was one of five core themes used by the European Union Agriculture, Food Security and Climate Change Joint Programme Initiative (FACCE JPI): "Environmentally sustainable growth and intensification of agriculture" (EUSAB, 2010: p. 7). The UK's Environment, Food and Rural Affairs Committee embedded a need for SI in their review of the 2013 reforms to the Common Agricultural Policy (CAP): "the aim for this round of CAP reform should be to enable EU farmers to achieve the 'sustainable intensification' that is required to meet the global challenges of feeding a predicted world population of 9 billion by 2050 without irrevocably damaging our natural resources", (EFRA, 2011: p. 23, para 64). In the following year the UK's Commission on Sustainable Agriculture and Climate Change concluded that "Sustainable intensification is potentially the most promising means of simultaneously increasing food production while achieving land-based mitigation [of greenhouse gases (GHG)], as long as non-crop land uses such as forestry, grasslands or wetlands are able to sequester more carbon or emit lower levels of GHGs than cultivated land" (Beddington et al., 2012: p. 28).

## So what is SI?

Baulcombe et al. (2009) in a report published by The Royal Society describes a SI system as one in which "yields are increased without adverse environmental impacts and without the cultivation of more land" (Baulcombe et al., 2009: p. ix). This concept clearly interested the Foresight Global Food and Farming Futures project which, observing that many systems of food production

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were unsustainable (Foresight, 2011: p. 10), concluded that "sustainable intensification is necessary" (p. 31). However, the Foresight report described SI as "simultaneously raising yields, increasing the efficiency with which inputs are used and reducing the negative environmental effects of food production" (Foresight, 2011: pp. 34–35).

Common to both the Royal Society and Foresight reports is the need for SI to increase agricultural yields. However, they differ on how this should be achieved. Baulcombe et al.'s (2009) view is that this should not be at the expense of *additional* environmental degradation or of expanding the area for land farmed. The Foresight report goes further to suggests that *existing* levels of environmental impacts should be *reduced* and specifies that raised production of food should be achieved by more efficient conversion of inputs into outputs. Moreover, it specifies that these changes should happen simultaneously. It is silent about the prevention of extending the area of land farmed.

It should be noted that SI is one of several terms currently used to organise policy responses to the challenges of producing more food to feed a growing population at the same time as protecting and enhancing ecosystem service provision. The FAO also uses the term "climate-smart agriculture" (CSA) which it defines as "agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals" (FAO, 2010a: p. ii). Godfray et al. (2010) have focused on the importance of reducing the "yield gap" (which is "the difference between realised productivity and the best that can be achieved using current genetic material and available technologies and management" (p. 813)). Beddington et al. (2012) have developed the "safe space" concept, and a wide range of organisations and individuals support some form of agro-ecological farming, for example integrated pest management, agro-forestry, organic agriculture and conservation agriculture (CA).

## Do these different definitions of SI have significant implications for policy and deliverable actions?

There is currently a debate whether agriculture and ecosystem services are best produced by "land sharing" or "land sparing". The essential difference is that "land sharing" produces agricultural and non-agricultural, ecosystem service outputs from the same area of land simultaneously, whereas "land sparing" allocates land use according to its comparative advantage.[1]

The definition used in the Royal Society report specifically states that SI systems should (i) raise farm production, (ii) not add to current levels of environmental degradation, and (iii) not involve converting any non-farmed land into farmland. This is clear support for the land sparing model. The Foresight report (2010) agrees with (i), suggests (ii) should reduce existing levels of negative environmental impacts and is silent on (iii). Further, it specifically supports reducing existing level of environmental impact by raising the productivity with which inputs are used (which is not the same as reducing the level of inputs currently used). Importantly, the Foresight report argues that land must "deliver multiple benefits simultaneously" (Foresight, 2010: p. 11). Whilst the Royal Society report lends its support to land sparing, the Foresight report shifts attention towards land sharing.

These two influential descriptions of SI therefore suggest quite different and in some ways opposite approaches to increasing food and reducing adverse environmental impacts. The implications of

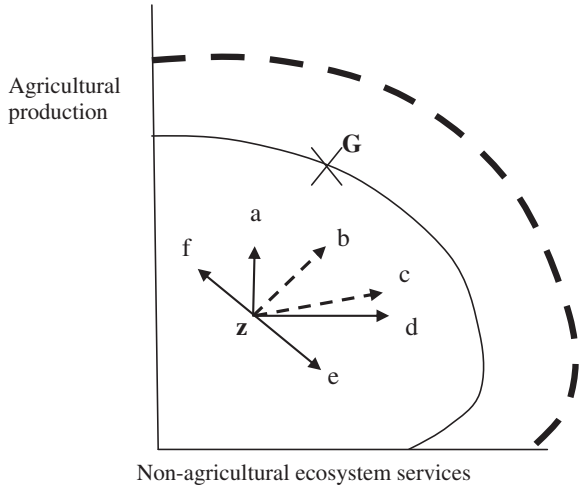


**Fig. 1.** Conceptualisation of sustainable intensification trajectories of farms within a UK context) (Elliott et al., 2013: p. vi). Farm G is on the PPF, farm z is inside this frontier. Adapted to include expansion of PPF due to innovative technologies.

the different definitions of SI on land use can be demonstrated by the conceptual model presented in Elliott et al. (2013) (see also Firbank (2012)). The model uses a production possibility frontier (PPF). A PPF depicts the various combinations of two outputs that can be produced using a constant amount of all factors of production. Fig. 1 shows a PPF with agricultural production on the *y*-axis and ecosystem services on the *x*-axis as the two outputs of land. It demonstrates the theoretical trade-off between these outputs. Notice that there are points on the PPF where agricultural production and ecosystem services are complementary, but that for the wider range of outputs they are competitive. Farms on the boundary of the PPF (e.g. farm G) are defined as the most efficient farms because they produce the maximum amount of any one product for any given level of the other product. These farms can simultaneously raise yields and ecosystem services only at relatively low levels of agricultural production (the complementary areas of the frontier). Therefore, the majority of farms on the boundary of the PPF can only develop a SI trajectory if the PPF shifts up and to the right, which can only happen by using new technologies (the dashed line in Fig. 1).

In Fig. 1, farm *z* produces both agricultural and eco-system services, and so is an example of land sharing. This is the approach supported by the UK's Environmental Stewardship Scheme (ESS) and as more than 70% of farmland is entered into ESS (and nearly all farmland is subject to cross-compliance management standards) this represents a normal situation for UK farms. Fig. 1 also shows that farm *z* lies inside the PPF. As it is not on the boundary of the frontier it has scope to raise input use efficiency using existing technology (either to increase agricultural production or ecosystem services, or both). Using the Royal Society report's (land sparing favouring) definition, farm z will exhibit SI if it changes its farming system to increase yields without reducing ecosystem service provision, such as shown by trajectory "a" in Fig. 1, or if it increases yield and ecosystem services simultaneously (e.g. trajectory "b" or "c").[2] Note however that trajectory "d" represents an improvement in ecosystem services without an accompanying increase in yield and therefore does not represent SI.[3] The Foresight's definition would also not accept trajectory "d" as representing SI (for

[1] For an introduction to land sharing and land sparing see POSTNOTE 418 (House of Parliament 2012). For further discussion see Garnett and Godfray (2012): pp. 15–17 and references therein.

[2] Elliott et al. (2013) provides case study evidence showing how some farms in Great Briton have practiced SI (p. xi), however they also note that "a number of farms which increased [crop] production also saw an adverse impact on environmental quality" (p. xii).

[3] However, the report does acknowledge that this would "represent an improvement over the *status quo ante*" (Elliott et al. 2013: p. vi).